Status of RFI in the 1400-1427 MHz passive band: The SMOS perspective.

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Abstract

The current paper describes the status of Radio Frequency interference (RFI) in the SMOS observations and the recent efforts performed by the SMOS team to mitigate the negative effects of the interfering sources. This efforts comprise new methodologies being introduced at the new level 1 processor in order to flag the observations affected by RFI and a continuous monitoring and reporting of the RFI sources worldwide, to request countries to protect the spectrum from illegal transmissions.

Introduction

European Space Agency's (ESA) Soil Moisture and Ocean Salinity (SMOS) mission was launched on 2 November 2009 with the objective of providing global observations for soil moisture and ocean salinity. SMOS carries the first-ever spaceborne L-band Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) in two dimensions [1]. MIRAS operates within the Earth Exploration Satellite Service (EESS) passive band at 1,400-1,427 MHz, which is also allocated to the Radio-Astronomy and the Space Research (passive) services. The 1,400 – 1,427 MHz frequency range is a protected band where all emissions are prohibited by the ITU Radio Regulations [2]. Furthermore, ITU urges administrations to ensure that unwanted emissions of active service stations in the adjacent bands do not exceed the maximum levels contained in Resolution 750 (WRC-07), noting that EESS (passive) sensors provide worldwide measurements that benefit all countries, even if these sensors are not operated by their country. Despite the existing regulations at international level, SMOS´ objective is disturbed by RF Interferences (RFIs) that jeopardize part of its scientific use in certain areas of the world.

In order to improve SMOS images over those areas affected by RFI sources, the SMOS team has put several strategies into place within the short, mid and long term timeframe [3, 4]. These strategies cover multiple areas: from data flagging and RFI image mitigation techniques to increase the RFI situation awareness, lobbying to

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improve the regulatory framework to ensure protection of the 1,400-1,427 MHz passive band and requesting cooperation of the spectrum management authorities at national level to enforce the radio-regulations.

Cleaning the spectrum

Over the last year, the SMOS team has continued to put a considerable effort in requesting the spectrum management authorities of the different countries to cooperate to ensure the protection of the 1400-1427 MHz passive band. This strategy has proven to be very beneficial in the early years of the mission, where a substantial number of RFI were switched off. The total number of active RFI has stabilised in the last year, since most of the cooperative countries have already either cleaned their territory from illegal transmissions or reduced the level of out-of-band emissions, but the efforts of monitoring the situation worldwide is still essential to prevent new interferences to appear. Figure 1 shows the probability map of RFI occurrence in the World by February 2014. An updated picture of the RFI scenario around the World, including statistics showing the type and services originating the interferences will be presented in the conference.

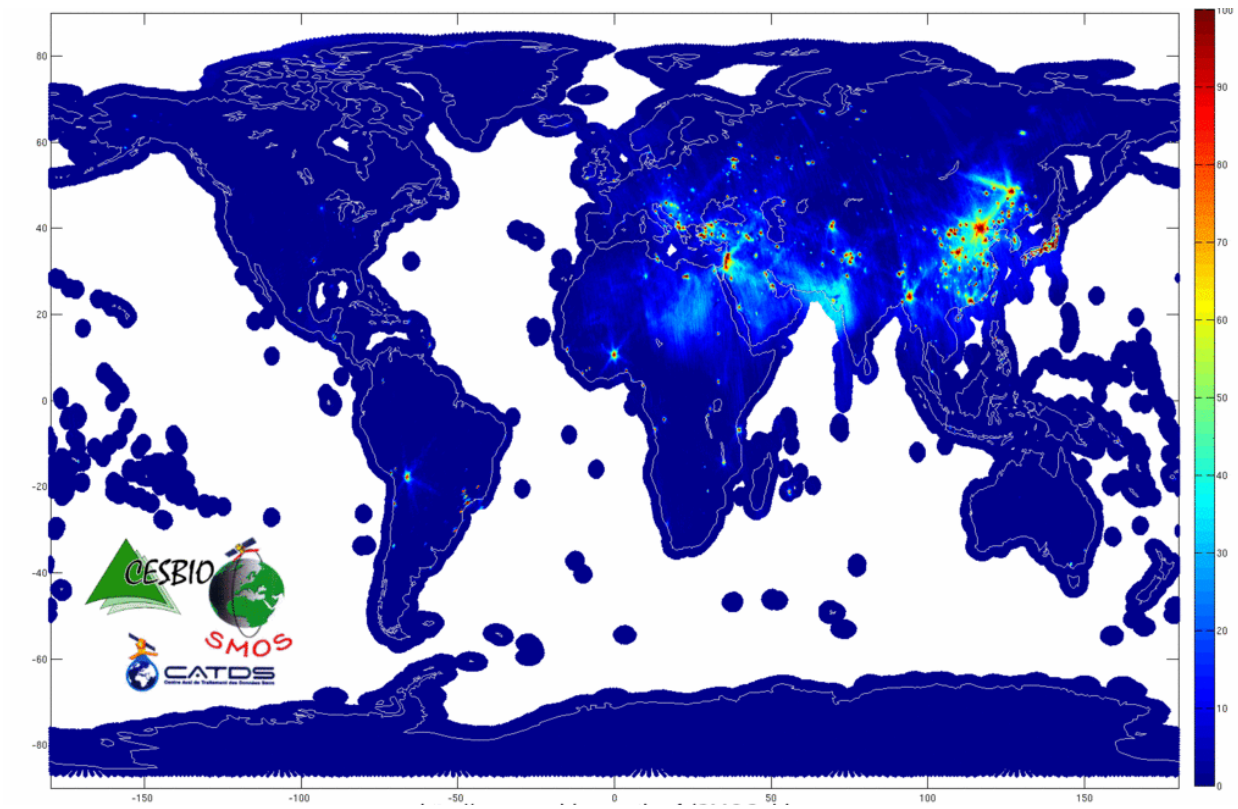

Figure 1: Sustained probability of RFI occurrence in SMOS observations for ascending passes during early February 2014

New flagging

The recent efforts in the SMOS team regarding RFI have been dedicated to improve the detection and flagging of interfering signals in SMOS observations in order to warn the users before they perform the retrieval of

geophysical parameters. The new level 1 operational processor (version 6.1.1) that will be in place mid 2014 includes several levels of flags depending on the impact of the RFI emissions in the SMOS snapshots.

Three different techniques scan the SMOS snapshots to find non-natural emissions. The first technique uses the measurements from the radiometer that measures the absolute temperature of the scene, the NIR, and searches for abrupt changes in the antenna temperature [5]. This is an indication of very strong RFI present in the SMOS images, and therefore flags the entire snapshot. A second technique flags any pixel at brightness temperature that exceeds the maximum natural emission on Earth. In this case any measurement above 400 K although this level is configurable. The third technique searches for active RFI from a database generated with the SMOS RFI data history, and flags a circular area around the source. The extension of the circle is determined by the intensity of the source in accordance with the MIRAS impulse response. In the cases that the RFI is very strong, the algorithm will also flag the tails extending from the source corresponding to the side-lobe levels of MIRAS. Figure 2 shows an SMOS snapshot on the left, and the corresponding flags on the right.

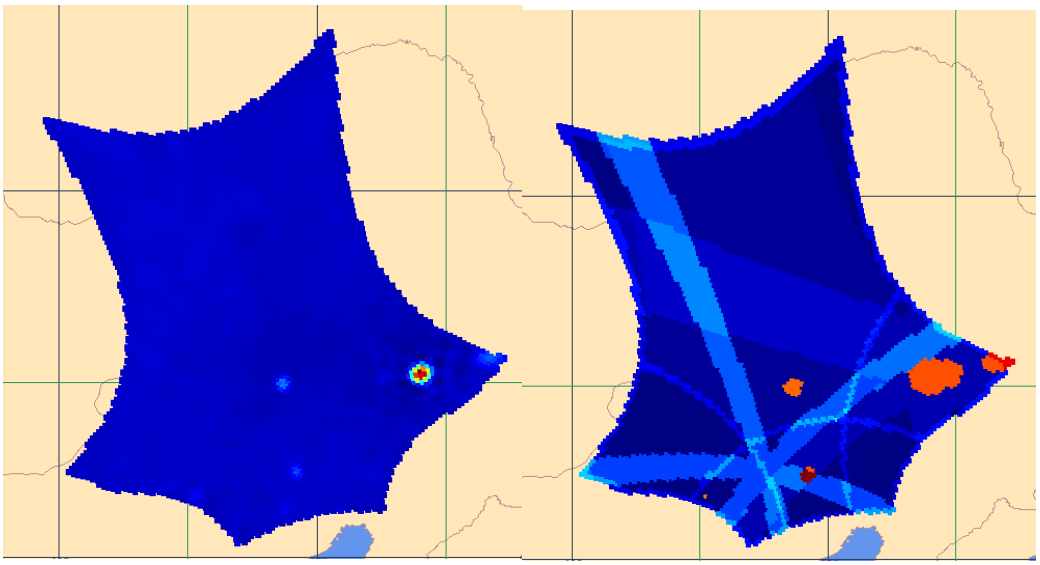

Figure 2: Left: SMOS X pol snapshot containing one strong RFI source and several moderate ones. On the right the corresponding flags for that same snapshot. Flags in orange correspond to the circle around the source. Flag in light blue correspond to tails extending from the source. Other flags such as the Sun flags, and border of the snapshot are also represented in the right image.

These three new techniques improve the level of confidence in the SMOS measurements. An analysis of the improved performance of the SMOS retrievals as a consequence of the new RFI flagging technique will be presented in the conference.

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